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CHEMISTRY IN THE ELEMENTARY SCHOOL

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[In the development of nature-study within the past decade, no branch of the subject has received so little attention as chemistry. There are several reasons, good and bad, for this neglect. Nature-study has always been more or less clouded with the story-book method, and this branch of the subject does not lend itself easily to such treatment. Fortunately, nobody yet has attempted to introduce the children to chemistry by reporting in story form a familiar conversation between "Mr." and "Mrs. Atom;" nor has anyone yet worked out the infinite literary possibilities that may lie in the detailed tribulations of the little "baby atoms." It is not to be expected, however, that we shall much longer escape a dramatic presentation of the lives of "Papa" and "Mamma Microbe," the effect of which will be to impress upon the vivid imagination of childhood the picture of something like a cross between a rhinoceros and a crocodile.

There is some difficulty in the fact that many of the phenomena belonging to the field of chemistry arise from changes that are obscure in their origin and difficult to observe. But the chief trouble is that most teachers seem to think that the only way to begin the subject is to start with certain experiments relating to chemical change which through endless repetition have come to be known as "classics." Whoever heard of beginning chemistry in any other way than by decomposing mercuric oxide and by combining iron filings and sulphur!

There are, though, many ways in which pupils come into contact with chemical phenomena. When proper attention is given to it, no other aspect of nature is more profoundly interesting to children. The following outline is intended to illustrate some of the points of contact which the child makes with the subject in his ordinary experiences, leaving it to the sense of the teacher to see how such work should be carried out in detail.—NOTE BY THE EDITOR.]

OCTOBER

THE COMPOSITE NATURE OF FRUITS; RELATIVE AMOUNTS OF CONSTITUENTS; PROPERTIES OF THESE CONSTITUENTS

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Compare different ripe fruits as to general proportion of water (juice) present.	See First Grade. Preservation of fruits and vegetables; first, as begun in the gathering, and transportation of fruit.	Constituents of fruit or plants: water, organic solid, ash. Note relation of ash in fruits with that part of the soil that will not burn.	Fruits and vegetables: constituents. Sugar: presence in fruits and vegetables as a preservative.	Plant growth: conditions of. Study of plant fiber: action of <i>acid</i> and alkali upon fibers (dyeing).	Preservation of fruits and vegetables: salt, spice, heat, sugar. Preparations for change in season: by plants, in light of chemical change.	Seed formation: result of chemical change. Rise of industries. Common metallic elements. Cu, Ag, Au, Fe, Pb; occurrence, properties, compounds, metallurgy, uses.	Changes in vegetable life: result of chemical change. Weather observation: barometer.
Dry the fruits; note loss of moisture.	Conditions preventing decay and fermentation.	Determine the presence of water in the soil. Trace a fruit from growing place to consumer; note method of preservation. Plants: parts, functions. Evaporation as a means of preservation.	Relation of soil constituency to growth. Temperature relations to growth. Thermometer.	Canning of fruit: conditions. Vinegar from apples: formation of acid. <i>Acid</i> and <i>alkali</i> tests.		Continue in November.	

NOVEMBER

CHEMICAL CHANGE SEEN IN DECAY (VEGETABLE AND ANIMAL); RELATION TO PHYSICAL CHANGE;
CONDITIONS OF DECAY

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Conditions of decay: means of preservation by nature; by man.	Weather observation; effect of frost in decay. Temperature below surface of ground several feet; value of this fact in preventing decay in hibernation. Grains: kinds. Flours: kinds. Properties of different products of wheat grains.	See Second Grade for first half of outline. Constituents of soil. Metals: Cu, Fe, Pb; where found; mining; melting; casting. Continued in December.	Swamps: how formed. Constituents of soils in general: formation of. Clay beds: formation of; Use of clay in brick; the making of bricks.	Milling of flour. Chemical properties of milled products. Soap making; action of <i>acid</i> upon <i>alkali</i>. Properties of resulting salts. Term: <i>neutralization</i>.	Product of fermentation: CO_2; experiment. Yeast: effect of temperature upon; yeast under microscope. Vinegar making. CO_2 a product of direct chemical action, as in baking powders.	Make and identify O and CO_2. Respiration $\rightarrow \text{CO}_2$; decay $\rightarrow \text{CO}_2$; chemical compounds $\rightarrow \text{CO}_2$ (baking powder). Substitutes in cooking, for baking powder, as molasses (if acid) and soda; sour milk and soda.	

DECEMBER

LIBERATION OF ENERGY; RESULTING FROM CHEMICAL CHANGE; OXYGEN

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Butter-making: constituents of milk; properties of fat; steps in butter-making.	Butter: see First Grade. Primitive methods of churning.	Starch: vegetables used as source of supply. By experiment make starch; cooking temperature of starch; properties; test for presence of.	Combustion giving rise to heat and light; combustible materials. Resulting product of combustion, CO_2 , compared with breath. Necessity of oxygen for combustion.	Making candles: primitive, modern. Fats used: wicks, snuffers. Structure of flame. Products of combustion in candle flame. See <i>necessity</i> of oxygen.	Heat the result of chemical change. Various methods for the production of heat. Heating of houses—methods. Lighting of houses. Light the result of chemical change.	Respiration: relation to body heat. Ventilation: necessity for—principles of—	
Making of flour: wheat ground in school-room.	Flour: continued from November.						
Compare the properties of fine, white, final product with coarser intermediate product as to thickening properties, etc.					Compare primitive with modern methods; relative values.		

JANUARY

FOOD PRINCIPLES; PROPERTIES; TESTS

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Continue work outlined for December. In cooking the fruits dried in the fall, note the large quantity of water required for cooking; compare by cooking fresh fruit of the same class.	Soils: note the comparative amounts of organic matter present; note moisture in different soils.	Constituents of flour: test for starch; separate gluten. Starch under microscope. Effect of high heat upon starch; e. g., sweetened crust of bread.	Extract starch from vegetables; test starch; properties of starch. Gluten in flour a proteid. Egg-albumen a proteid. Cooking temperature of proteids. Sugar: kinds, distribution, manufacture of, use.	Starchy foods: value. <i>Solubility</i> of starch; effect of heat upon starch; of moist heat, dry heat. <i>Solubility</i> of egg-albumen. Effect of heat. Gluten in flour; value in bread-making.	Conversion of starch into sugar. Albumenoid in milk, compared with egg-albumen; how coagulation is effected.	Starch: structure of grain. Compare carbohydrates and proteids as to food value. Dietary studies: rough food analyses.	

FEBRUARY

CARBON: SOURCE, FORMS; CARBON-DIOXIDE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Fuel on farm; fuel used in city. <i>Thermometer:</i> the reading of; read the freezing-point.	Fuels in primitive life: turf, wood, etc.; compare with fuel of today.	Combustible materials. Incombustible materials. Preservation of meats and fish a winter industry as well; preservation by salt, smoke, drying.	Systems of heating: relative values. Heat transmission: methods. Metals: smelting.	Presence of carbon in all combustible substances. Review: candle dipping; comparison of flame. Alloys: making of; those suitable for dishes.	Forms of carbon: sources and uses of CO₂.	Combustion defined in broad sense. Use of matches: sulphur match, lucifer match, phosphorous match. Phosphorous: (1) properties, (2) kinds. Principle of safety match. Gaseous product of drawing match	Heating, lighting, ventilation of the modern house.

MARCH

COMBINATION (OXIDATION), CONDITIONS OF; KINDS OF; FLAME STRUCTURE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Conditions of combustion — general. Recognize a few of the materials (substances that will not burn).	Review February outline. Combustible materials. Conditions of combustion.		Old methods of "starting" a fire: flint, steel, tinder. (Sacredness of hearth.) Relation of heating system to system of ventilation.	Structure of flame: necessity of oxygen. Conditions under which plants grow; hotbed. Decaying matter generates heat.		Sources and uses of CO_2 .	

APRIL
WATER: SOURCES, PROPERTIES (CHEMICAL AND PHYSICAL), PURIFICATION

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Forms of water: rain, melted snow and ice. Experiments in germination of plants; needs of plants.	Compare "city" water and "well" water with that obtained as rain, melted ice, snow, etc. Needs of plants. Try the different soils in January study; how do they meet the needs of plants?	Sources of water; properties of "hard" and "soft" water. Something in the one requires the use of more soap.	Sources of water: (1) conveyance, (2) properties, (3) characteristics. Purification: by distillation, filtration. Drainage.	Forms of water: value of soap in using "hard" water. Soap-making reviewed. Distinguish "hard" and "soft" soaps.	Water: boiling point, freezing point. Fahrenheit and Centigrade. Needs of plants. <i>Nitrogen</i> supplied by some.	Action of certain metals upon water. Sodium — + water; sodium hydroxide; + hydrogen. Note alkalinity; NaOH for med. Collect and test <i>hydrogen</i> .	Form in which water occurs in substances: (1) water of crystallization (alum); (2) integral part of substance (sugar); (3) water between crystals, salt. Use of terms, hygroscopic effervescent, etc.

Maple sap: boil to obtain sugar.

Evaporation: Power of chemical change in tree; building up sugar.

Dissolve much sugar; note consequent hardening in solution.

MAY

ATMOSPHERE: COMPOSITION; AFFECTED BY RESPIRATION, HENCE VENTILATION; PRESENCE OF MOISTURE; PRESSURE; TEMPERATURE

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
Reading thermometer.	Composition of atmosphere very variable. Discover the presence of water, dust, gases in air.	Relation of plants to soil, light, and air. Experiments indicating the result if either in insufficient quantity or quality.	Relation of plants to soil.	Weight of air; constituents of air. Determine roughly the relative proportion of these constituents.	Air in room, in upper and lower part. As result: what import in ventilation? Devise system of ventilation. Necessity of pure air for blood.	<i>Analysis of air:</i> Burn phosphorus in inclosed space. Remaining gas does not support combustion; is not O, not CO ₂ , but <i>nitrogen</i> . Determine relative proportions of CO ₂ , N, and O, and moisture in the air.	

JUNE

ELECTRICITY; RESULT OF CHEMICAL CHANGE; EXPERIMENTS IN GENERATING ELECTRICITY

First Grade	Second Grade	Third Grade	Fourth Grade	Fifth Grade	Sixth Grade	Seventh Grade	Eighth Grade
						Make an electric battery; principles of; magnets, magnetism.	

Proper understanding of chemical terms. All of outline illustrated and worked out experimentally.